AIR QUALITY ATIKOKAN

Annual Report, 1977

Ministry of the Environment
Ontario

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ONTARIO MINISTRY OF THE ENVIRONMENT
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SUMMARY

The Ontario Ministry of the Environment has conducted an air quality assessment programme in the Atikokan area since 1971 and has coordinated sampling surveys carried out by two local iron ore mining companies since 1964. This report presents results of the Ministry's 1977 programme, which included an evaluation of tree growth data and measurements of particulate pollutants and sulphation rates.

A small-scale study of diameter growth of jack pine trees near one of the mines indicated that average growth decreased slightly after mining operations began. However, no relationship could be established between decline in growth and airborne contaminants from the mines.

Dustfall exceeded Ontario air quality objectives in an area near the mines. Average levels were similar in 1976 and 1977, and no further decrease is expected before the anticipated termination of mining activity about 1980. Dustfall levels and suspended particulate concentrations were both in compliance with Ontario regulations in the town of Atikokan. Sulphation rates were very low at all monitoring sites, indicating that average sulphur dioxide levels were satisfactory throughout the survey area.

INTRODUCTION

Since the mid-1960's, air quality investigations have been undertaken in the Atikokan area in the vicinity of two iron ore mines and pelletizing plants. Staff of both companies, as well as the Ministry of the Environment, have participated in these studies. Earlier reports (1, 2) summarized results from vegetation, soil, and snow sampling surveys and air monitoring programmes conducted from 1964 to 1976.

Because of the accumulation of a large data base and the continuity of relatively uniform levels of atmospheric emissions from the mining operations, the scope of air monitoring investigations has decreased in recent years. In 1977, an evaluation was completed of growth in jack pine trees sampled in 1974. Monitoring was also continued for dustfall, suspended particulate and sulphation rates.

VEGETATION AND SOIL ASSESSMENT

Tree Growth

Chemical analysis of vegetation, soil and snow samples has shown that moderate amounts of arsenic and very large quantities of iron have been deposited in the vicinity of the two pelletizing plants since mining operations began. Highest levels of both pollutants have been recorded to the northeast of the Caland Ore plant.

Although plant foliage near both pelletizing plants is usually covered with a heavy deposit of iron oxide dust, no adverse effects to local vegetation have been documented since mining began. Histological examination of such foliage has shown that dust particles accumulated on, or were imbedded in, leaf surface tissue. No particulate matter was found inside leaves and no abnormalities were observed in internal cell structure.

In August, 1974, growth of jack pine trees was investigated in one of the areas where dust deposition was heavy. The study location was a lake shoreline ("Lower Basin A") about 1.5 km (kilometres) northeast of the Caland Ore pelletizing plant. The shoreline, along the north side of the lake, was fully exposed to airborne dust emitted from the plant area. Eight trees, typical of the stand, were selected at intervals along a transect beginning at the shoreline and extending inland for about 140 m (metres) to the northeast. Tree diameters, at breast height, ranged from about 20 to 35 cm (centimetres) and heights from 16 to 24 m. Trees near the shoreline had stem bark which was conspicuously rust-coloured, particularly on the side facing the ore plant. This discoloration was less evident on trees inside the stand. Two cores, from opposite sides of the stem, were obtained with an increment borer at breast height from each tree. Radial growth was determined for two, 8-year periods, one just before pelletizing plant start-up and one immediately after. Growth data are presented in Table 1. Results indicate that, on average, tree growth was 9 percent less in 1966-74 than in the 8 preceding years. There was no apparent relationship between tree growth and distance from the shoreline. The modest difference in growth rate between pre- and post-operational periods may not be significant nor may it reflect effects of emissions from mining activities. The effects on tree growth of factors such as local climate, soils and stand density might well account for any observed differences in growth rates. Resolution of the separate influence of each of these effects would require a larger, more complex study.

AIR MONITORING

PARTICULATE POLLUTANTS

Dustfall

Dustfall, one of the most visible classes of air pollutants,

comprises particulate matter which settles out from the atmosphere under the influence of gravity. It is measured by exposing open-top plastic jars for 30 days and weighing the collected matter. Results are expressed in grams per square metre (g/m^2) per month.

Figure 1 shows the dustfall monitoring locations in operation at Atikokan in 1977. The monthly values are given in Table 2 and the annual averages are plotted in Figure 2. The Ontario monthly ambient air quality objective of 7 g/m^2 (= 20 tons/square mile) was exceeded most frequently at sites closest to mining operations, with highest values being recorded in the second half of the year. Average dustfall above the annual objective of 4.6 g/m^2 (= 13 tons/square mile) was monitored at 3 of 8 sites. Average dustfall levels and dustfall distribution patterns (Figure 2) were very similar in 1976 and 1977. Dustfall in 1977, while generally lower than that reported between 1967 and 1975, is not expected to show any further significant decrease before the anticipated termination of mining and ore processing operations about 1980.

Suspended Particulate

Suspended particulate constitutes particulate matter of small size which remains in the atmosphere for extended periods. Every sixth day, a measured volume of air is drawn through pre-weighed glass fibre filters for a 24-hour period. Filters are then re-weighed to determine the quantity of dust collected. Results are expressed in micrograms per cubic metre of air ($\mu g/m^3$). The Ontario ambient air quality objectives for suspended particulate are 120 $\mu g/m^3$ for 24 hours and 60 $\mu g/m^3$, annual geometric mean.

Suspended particulate concentrations recorded in 1977 are presented in Table 3, together with prevailing wind directions and average wind speeds for sampling dates. The 24-hour air quality

objective of 120 $\mu g/m^3$ was exceeded in only one of 52 samples. The annual geometric mean of 30 $\mu g/m^3$ was the same in both 1976 and 1977, and well below the Ontario objective of 60 $\mu g/m^3$. Average particulate levels were slightly lower with easterly prevailing winds (26 $\mu g/m^3$) than those associated with winds from the north, south or west (38, 37 and 36 $\mu g/m^3$, respectively). This finding indicates that airborne emissions from the mining operations did not contribute significantly to suspended particulate concentrations in the town of Atikokan.

GASEOUS POLLUTANTS

Sulphation Rates

Sulphation rates are determined by exposing small plastic dishes, coated with lead dioxide, to the atmosphere for 30-day periods. Lead dioxide reacts with gaseous sulphur compounds to form lead sulphate. The amount of sulphate formed is analytically determined and results reported as milligrams of sulphur trioxide per hundred square centimetres per day (mg SO_3/100 cm^2/day). In addition to sulphur dioxide, the coated plates will respond to the presence of other reactive sulphur compounds, such as hydrogen sulphide or mercaptans. However, since compounds of this type are not known to occur at detectable levels in the Atikokan area, the sulphation rate measurements in this survey are considered to provide a rough estimate of average sulphur dioxide concentrations.

Sulphation monitoring sites are plotted in Figure 1 and 1977 data are contained in Table 2. As in 1976 and earlier years, the sulphation rates in 1977 were uniformly low. No monthly value approached the Ontario objective of 0.70 mg/100 cm^2/day. There was therefore no evidence that the average daily sulphur dioxide emission of 75 tons from the two mines had any appreciable influence on sulphation rates measured in the surrounding area.

ACKNOWLEDGEMENTS

Assistance from the following organizations is gratefully acknowledged:

- Steep Rock Iron Mines Limited and Caland Ore Limited for operation of the dustfall and sulphation monitoring network and for determination of dustfall weights.
- Atmospheric Environment Service, Environment Canada, Atikokan, for operation of the high volume sampling unit.

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1. Griffin, H. D. 1976. Air quality, Atikokan. Annual Report, 1975. Ontario Ministry of the Environment.

2. Griffin, H. D. 1977. Air quality, Atikokan. Annual Report, 1976. Ontario Ministry of the Environment.

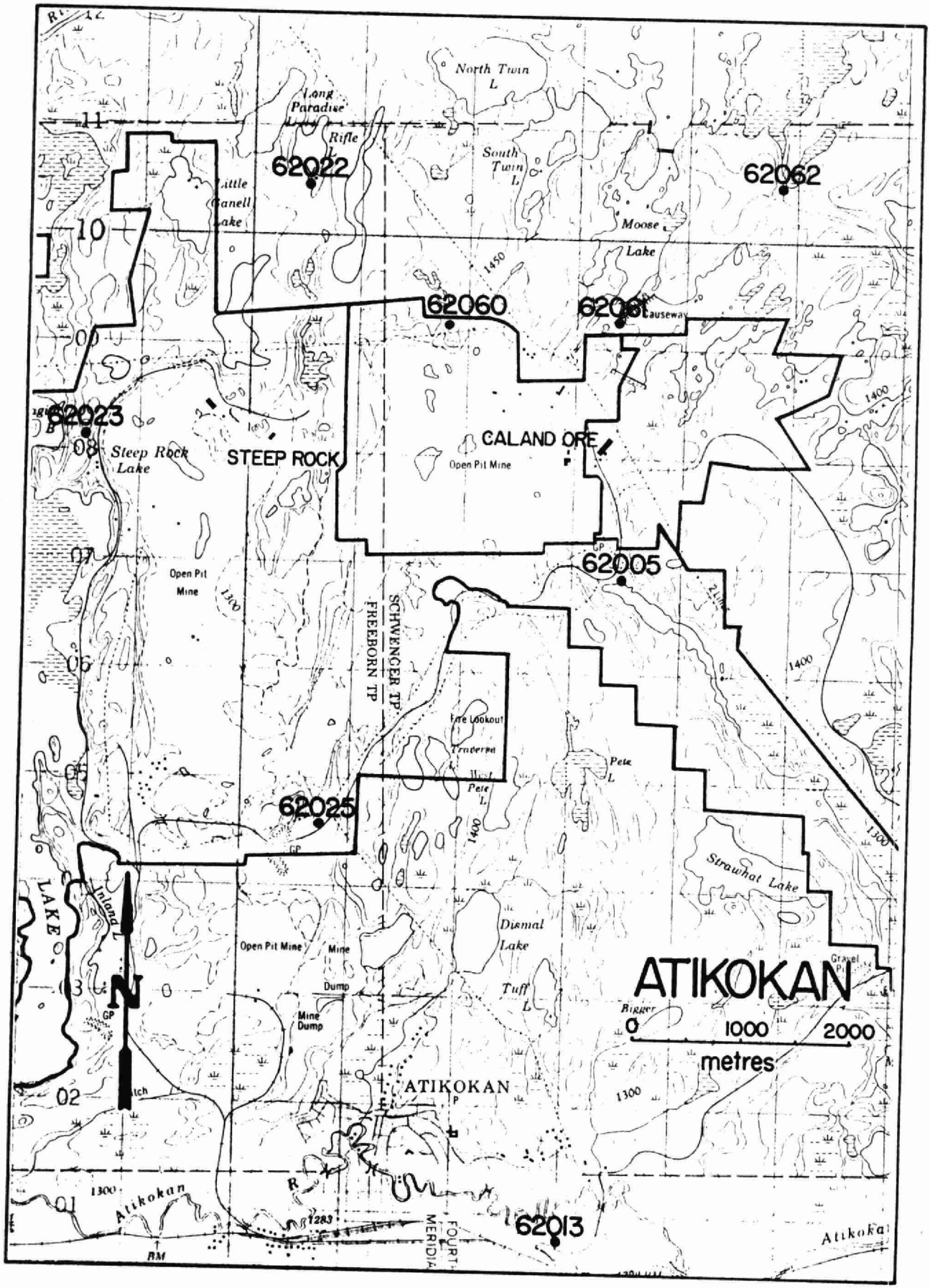

Figure 1. Air quality monitoring sites, 1977 (except station 62063).

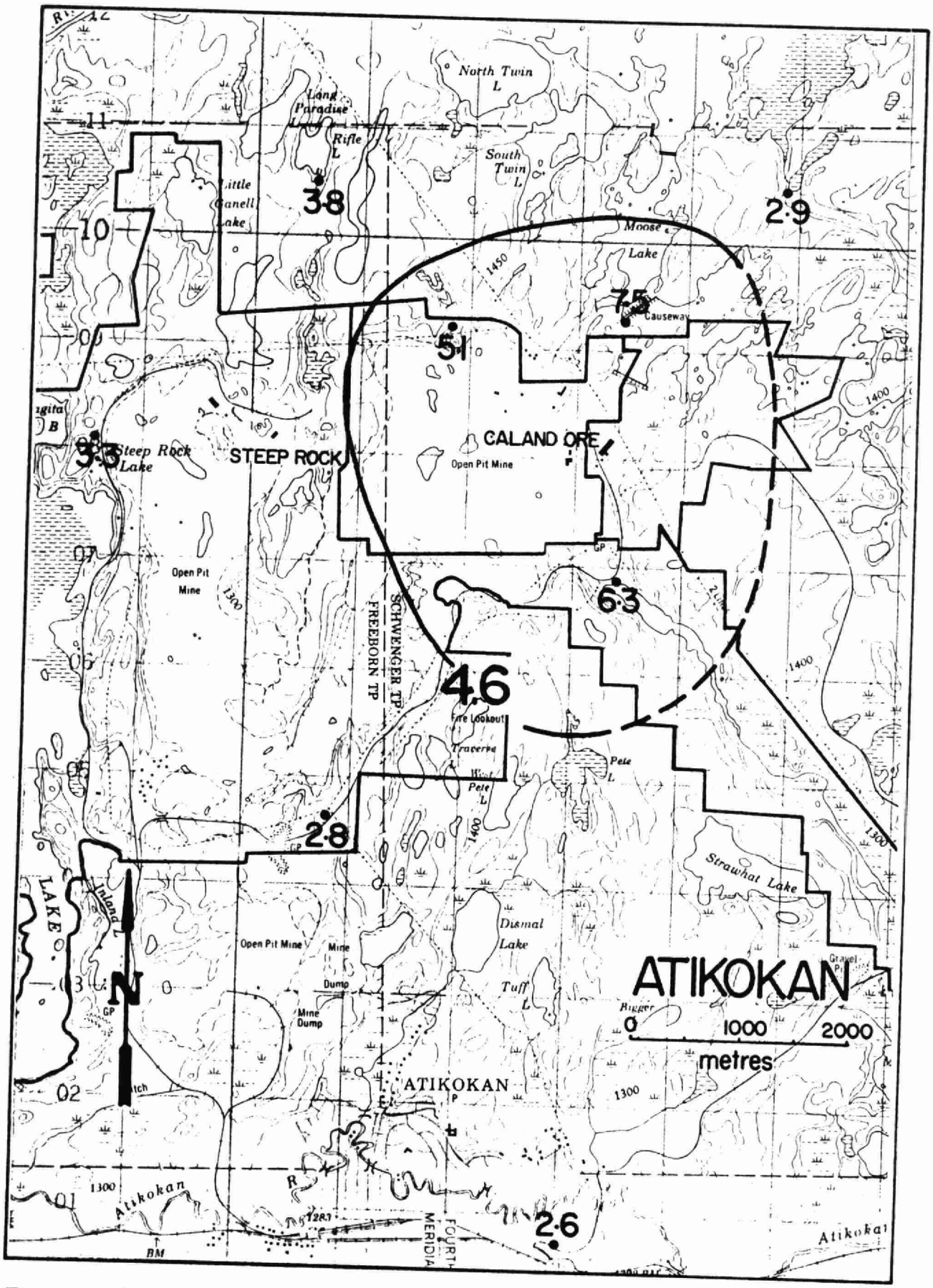

Figure 2. Average dustfall, 1977 (g/m^2/ 30 days).

TABLE 1. Radial growth, breast height, in jack pine trees 3 km northeast of Caland Ore pelletizing plant.

Tree number	Distance (metres) from shoreline	Radial growth[a] (mm)		
		1957-65	1966-74	Difference (%)
1	0	7.6	8.9	+17
2	14	9.6	8.2	-15
3	20	9.6	9.6	nil
4	35	8.9	6.6	-26
5	57	10.2	9.6	- 6
6	76	12.4	11.7	- 6
7	95	12.0	12.0	nil
8	138	10.4	6.6	-37
Averages		10.1	9.2	- 9

[a]Average of two cores per tree.

TABLE 2. Dustfall and sulphation rates, Atikokan, 1977.

Station	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
		Dustfall (g/m^2/30 days)												
62005	Fairweather	2.4	1.8	1.8	4.2	6.6	6.3	6.3	6.0	15.8[a]	6.6	14.7	3.2	6.3
62013	Atikokan	1.0	1.4	1.4	2.8	4.6	3.8	2.8	2.8	3.8	2.8	3.2	0.7	2.6
62022	Mary Lake	5.1	1.4	3.2	2.6	7.1	3.9	4.5	3.0	3.4	3.0	4.9	3.4	3.8
62023	Water Tower	2.7	1.6	3.2	2.2	3.1	4.8	7.1	1.7	3.5	2.0	3.8	4.2	3.3
62025	Pal Lake Road	1.4	3.2	3.2	1.9	4.0	3.0	4.0	2.9	2.4	2.7	2.9	2.4	2.8
62060	Lime Point	2.1	1.0	1.4	4.9	9.4	2.4	7.0	3.8	8.4	5.6	12.2	3.2	5.1
62061	Moose Lake Dam	2.4	2.4	2.4	4.6	7.0	6.0	13.0	7.7	18.9	9.8	13.6	1.8	7.5
62062	Mando Road Dump	1.4	2.8	2.8	2.4	3.5	3.8	4.6	2.1	2.1	4.9	3.5	1.0	2.9
		Sulphation rate (mg SO^3/100 cm^2/day)												
62005	Fairweather	< .03	.03	.09	.11	.08	.04	.21	.04	-	.04	.07	.07	.07
62013	Atikokan	< .03	.04	.09	.11	.08	.04	.16	< .01	.09	.09	.09	.11	.08
62022	Mary Lake	< .03	< .03	.10	.11	.09	.08	.09	.07	.06	.06	.11	.02	.07
62023	Water Tower	< .03	< .03	.10	.11	.09	.07	.09	.04	.06	.03	.06	.06	.06
62025	Pal Lake Road	< .03	.03	.10	.10	.11	.07	.09	.07	.06	.03	.04	.02	.06
62060	Lime Point	.08	.04	.09	.03	.05	.04	.24	.04	.04	.04	.04	.04	.06
62061	Moose Lake Dam	.05	.03	.09	.03	.05	.04	.16	.13	.14	.09	.04	.04	.07
62063	Nym Lake	-	-	-	-	-	-	-	-	-	.03	.04	.10	.06

[a]Values above objectives of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 3. Total suspended particulate, station 62013, Atikokan, 1977.

Date	µg/m^3	Wind[a]	Date	µg/m^3	Wind
Jan 1	11	NW 7	Jul 6	52	NW 4
7	21	W 4	12	28	NW 14
13	22	E 2	18	54	S 10
19	18	W 2	24	27	N 6
25	12	SSW 8	30	19	SE 9
31	11	WNW 16			
			Aug 5	33	WSW 7
Feb 6	50	W 6	11	29	W 16
12	14	NNW 12	17	-	- -
18	20	NW 7	23	39	WNW 7
24	13	ENE 10	29	37	SVL 3
Mar 2	29	W 6	Sep 4	17	N 4
8	45	SSW 6	10	42	W 7
14	-	S 4	16	51	SVL 7
20	36	WNW 8	22	31	ESE 10
26	43	SE 8	28	55	W 5
Apr 1	38	SSE 9	Oct 4	62	W 5
7	44	NNW 10	10	24	W 9
13	65	ENE 2	16	53	S 8
19	11	E 6	22	-	- -
25	69	NW 5	28	<u>180</u>	SVL 1
May 1	116	WNW 7	Nov 3	62	W 12
7	64	W 10	9	38	N 12
13	-	- -	15	11	E 4
19	-	- -	21	20	W 22
25	-	- -	27	24	S 1
31	-	- -			
Jun 6	-	- -	Dec 3	16	W 7
12	46	SE 5	9	11	N 12
18	19	SVL 13[b]	15	13	SVL 4
24	73	NNW 5	21	15	NNW 12
30	35	WSW 14	27	-	- -

[a]Prevailing wind direction and speed (kph).

[b]SVL = Several.

[c]Values above Ontario objective of 120 µg/m^3 are underlined.


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